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Had this specimen thus "bleached" on being removed from one tank to another, done so on being taken wholly from the water, and, thus faded, had been preserved in alcohol, might it not have been looked upon as an *Aphroderus albidus* nov. spec., and thus additional synonymy been offered to the confusion now existing? Is it, in fact, safe to consider color as of *any value* as a specific character, unless by comparing many specimens, and finding the variation uniform and without gradations? We have found the "sun-fish" as a group, to vary very much in accordance with the character of the stream in which they were found; and in an aquarium the "banded sunfish" (*Mesogonistius chaetodon* Gill), is verily kaleidoscopic. The black bands actually sometimes *wholly* disappear!

THE SPORES OF LICHENS.

BY H. WILLEY.

THE importance of the spores in the study of lichens, will perhaps render interesting a more extended reference to this branch of lichen history. The spores were known to Micheli, who figures those of several species in his "Nova Genera Plantarum," 1729, as did also Acharius in his "Lichenographia Universalis," 1810. But he made no use of them in his system. The great work of Fries, "Lichenographia Europæa Reformata," 1831, has no reference to the spores, excepting a few remarks in regard to their germination; but Eschweiler in the same year, made a somewhat careful examination of them, and noticed their various forms, although he endeavored in vain, he says, to make use of the spore-case in distinguishing genera. Fée, in the supplement to his "Essai," 1837, was the first to do this, and to figure and describe accurately the spore-cases and spores. But

De Notaris in 1846, from which period Krempelhuber dates the modern period of Lichenology, fully inaugurated the new method, and established it on a solid foundation. He pointed out the unity of the spore-type in many natural genera, and declared that species in which the spores presented important differences could not be grouped together. But the results of his labors do not appear to have been combined into a general system. Norman, in Norway, 1852, Massalongo, in Italy, 1852, and Koerber in Germany, 1854-1859, continued his work, and based their systems to a greater or less degree, on spore characters, while the younger Fries, Trevisan, Stitzenberger and others have labored successfully in the same field, and made important contributions to this department. No description of a lichen is now considered adequate which does not give an account of the spores, when they are to be found.

The Italian school, however, has attributed too great importance to minor distinctions in the size of spores, their septation, and number in the spore-case, attaching great importance to micrometric measurements, and thereby increasing the species and genera to a most unwarrantable degree, and not unfrequently violating natural affinities, answering no useful end and tending rather to create confusion than to advance true science. A few instances may serve to illustrate this. *Pyrenula nitida* Schær. is a very common bark lichen, and subject to but slight variation. The average length of the spores is from .018 to .022 millimetre; but specimens occur, which cannot be separated from it, in which they measure constantly from .030 to .038. *Arthonia velata* Nyl. is another instance in which the spores in some specimens are constantly nearly twice as large as in others. The spores of *Sagedia chlorotica* Ach. are described in the European forms as constantly 4-blastish, measuring from .018 to .023. Here they are usually from 4 to 6-blastish, and measure from .025 to .047, and it is only recently that I have found specimens with constantly 4-blastish spores, a

little smaller than the European, and measuring from .014 to .020. *Sagedia cestrencis* Tuck. is another example, though I am doubtful whether my specimens are different from *S. carpinea* Pers. As it occurs on the beech, the spores are fusiform, and measure from .034 to .038, while those on the hemlock, referred to the same species, are acicular and from .072 to .118. But perhaps the difference in form would justify making this a distinct species. *Rinodina sophodes* Mass. and *Biatora rubella* Fr. are two very variable species, but specimens referred to each vary in the former from .010 to .025, and in the latter from .018 to .075.

So in regard to the number of spores in the spore-case. The form of *Rinodina sophodes* in which the spore-cases contain twelve or more spores, can hardly be distinguished from that in which there are only eight, though Th. Fries makes it a separate species, under the name *R. polyspora*. I have found specimens of *Buellia microcarpa* D. C. which do not differ from the common form more than the two forms of *R. sophodes*, but in which there are from eight to sixteen spores in a spore-case; and a parasitic lichen on the thallus of a Saxicoline *Pertusaria* which appears to differ from *Buellia parasitica* Flk., only in the spore-cases containing a large number of spores. These examples might be numerously increased, but they are perhaps sufficient to show that too much importance should not be attached to what Professor Tuckerman calls "mere gradual differences."

Nylander, the great French lichenist and the antagonist of the German-Italian school, does not seem to attach sufficient importance to the differences in spore characters. In his remarks in his "Synopsis" on specific characters in lichens, he contents himself with a few indefinite observations in regard to them, and in his classification makes no generic distinctions based on form or color. Thus *Rinodina* is included under *Lecanora*, and *Buellia* under *Lecidea*. Indeed he seems to consider the spermatia as more important classificatory organs than the spores. In his descriptions, however,

he gives the forms of the spores, though not always accurately, and their measurements. While the Italian and German writers on the one hand tend to too great a subdivision of genera and species, Nylander, on the other, is frequently too comprehensive, though this is perhaps the safer error of the two.

Professor Tuckerman of Amherst, has expressed briefly his views on the value of spore characters, in his "Lichens of California," 1866, and has laid the foundation of a more sound and instructive doctrine on this subject than previous writers. In his opinion, which has been followed in what precedes, "less weight than has often been assumed should be given to spore differences of a merely gradal character, or such others as depend only on mensuration, and more to those that seem typical." He considers that there are "two well defined kinds of lichen-spores, complemented in the highest tribe only by a well-defined intermediate one. In one of these (typically colorless) the originally simple spore, passing through a series of modifications, always in one direction, and tending constantly to elongation, affords at length *the acicular type*. To this is opposed (most frequently but not exclusively in the lower tribes, and even possibly anticipated by *the polar-bilocular sub-type* in *Parmeliacei*), a second (typically colored) in which the simple spore, completing another series of changes, tending rather to distension and to division in one direction, exhibits finally *the muriform type*." In accordance with this view *Rinodina* is distinguished from *Lecanora*, and *Buellia* from *Lecidea*. *Theloschistes parietinus* is separated from *Physcia*, a genus with colored spores, and placed in a distinct genus, the type of whose spore is the *polar-bilocular*. On the other hand *Biatorea rubella* would not be separated from that genus, which includes species with simple spores, merely on account of its septate spores, nor *Buellia petræa* placed in a distinct genus, *Rhizocarpon*, on account of its muriform spores, nor *Lecanora cervina* on account of its polysporous

spore-cases. It is to be observed, however, that the typically colored spore is often, as Professor Tuckerman expresses it, decolorate. Thus the spores of *Buellia petræa*, are often, and always, so far as I have observed, in a form which occurs on rails, colorless, and frequently only 2-blastish. Similar conditions also occur of *Rinodina sophodes* and *R. ascociscana*. *Pertusaria* is another genus in which the spores should probably be considered as typically colored. They are usually of a yellowish tinge, and in one specimen of *P. leioplaca* they were of a rich golden brown. There are many genera in which species with spores belonging to the typically colored series, have spores always, so far as observed, colorless, or "decolorate." In the genera of all the great families of lichens will be found spores corresponding to these various types; and a table might be constructed, showing the analogies throughout. But into the subject of lichen classification it is not my purpose here to enter.

Our illustrations in the preceding number of the NATURALIST show the different types of spores as thus distinguished; those of *T. parietina* being polar-bilocular, those of *Biatora rubella*, acicular, and those of *Buellia petræa*, muriform. The adoption of this idea will certainly introduce an order and clearness into lichenology which it has hitherto lacked, and will do away with a host of genera of the German and Italian writers, which serve only to encumber the books and to embarrass and confuse the student. There are perhaps some exceptions, as Professor Tuckerman admits, in regard to *Gyalecta*, and as is perhaps the case also with *Arthonia*. But these may disappear with further knowledge, and we have to thank the Professor for an idea which greatly simplifies a difficult study, and whose advantages, as he justly remarks, far outweigh its difficulties. He has promised a further discussion of the subject in his forthcoming work on the Genera of North American Lichens.